mation of two gravitating bodies towards each other, and their separation, were the only points which offered this kind of coincidence; and therefore, using the earth as one gravitating body, he employed a cylinder of metal, glass, resins, or other substances, as the other, and endeavoured to ascertain when the latter was allowed to fall, being surrounded by a helix of wire, whether any electric current was generated. Sometimes the cylinder was allowed to fall through the helix; at other times with the helix; and occasionally the helix was made the falling body. But when the various sources of error which sprung up were gradually removed, no traces of electric action remained which could be referred to the power of gravity.

In order to obtain a greater effect, an aparatus was employed (being nearly that used in the 23rd Series of these Researches) by which the effect of raising a body from the earth could be combined with that of a falling body by the fit use of commutators (if any action at all were produced). The apparatus was very good, and gave exceedingly delicate results, as was shown by other consequences of its action; but in respect of gravity it produced no effect whatever. Notwithstanding his failure in obtaining any experimental relation between gravity and magnetic or electric force, the author still expresses his conviction that there is a relation, and his hopes that it may be hereafter practically demonstrated.

2. "Experimental Researches in Electricity." Twenty-fifth Series. On the Magnetic and Diamagnetic Condition of Bodies. By Michael Faraday, Esq., D.C.L., F.R.S. &c. Received September 9, 1850.

As the author could find no polarity in diamagnetic bodies when under magnetic influence (a result described in the 23rd Series of these Researches), he endeavoured to discover some other physical condition of them, and of magnetic bodies, by which he might obtain an insight into their respective natures, and establish the true place of the magnetic zero; and considering the power with which a magnetic body moves, or tends to move, from weaker to stronger places of action, and that of a diamagnetic body to pass from stronger to weaker places of action, he hoped to obtain some results of condensation with the first class, and of expansion with the second, when they were subjected to very strong magnetic action; the respective bodies being selected from the class of gaseous substances, in which change of volume can be easily produced and measured. In the first place, therefore, a ray of light was passed over the surface of powerful magnetic poles surrounded by different gases, and the place of its source carefully examined by telescopes, micrometers, and other means, to ascertain whether the layer of air in contact with the poles was affected in its refracting force; but though the experiment was made in oxygen, nitrogen, and other gases, not the slightest effect was visible.

Resigning this process, therefore, two air-tight chambers were made, in which the magnetic poles formed the chief part of the internal surface of the chamber. The one was formed by bringing the flat ends of the two poles to within $\frac{1}{60}$th of an inch of each other, with a frame all round to form the sides; and the other by

cutting away the central parts of an iron cylinder so as to give it the form of an hour-glass, and then enclosing that part by an air-tight copper tube. Cocks were attached to these chambers for the introduction and removal of gases, and for the application of gauges, which were able to indicate a change of volume equal to the $\frac{1}{100000}$th part of the contents of the chamber. When any given gas was introduced into the chamber, and the latter then placed between the poles of the electro-magnet, any possible alteration of volume would be shown by the gauge as soon as the magnet was rendered active; but whatever gas was employed, or whatever power of magnet used, not the slightest change was produced.

Thinking it possible that there might be expansion in one direction and contraction in another, the gases were then examined as to the production of any currents in them, but no traces of such appeared.

From these results, the conclusion was arrived at by the author, that the motions of magnetic and diamagnetic bodies in each other do not appear to resemble those of attraction or repulsion of the ordinary kind, but to be of a differential action, dependent perhaps upon the manner in which the lines of magnetic force were affected in passing from one to the other during their course from pole to pole; the differential action being in ordinary cases between the body experimented with and the medium surrounding it and the poles. A method of showing this action with the gases is described, in which delicate soap-bubbles are made to contain a given gas, and these, when held in the magnetic field, approach, or are driven further off, according as they contain substances, magnetic or diamagnetic, in relation to air. Oxygen passes inwards or tends towards the magnetic axis, confirming the results formerly described by the author in his account of his investigations of flame and gases.

Perceiving that if two like bubbles were set on opposite sides of a magnetic core or keeper cut into the shape of an hour-glass, they would compensate each other, both for their own diamagnetic matter and for the air which they would displace; and that only the contents of the bulbs would be virtually in a differential relation to each other, the author passed from bubbles of soapy water to others of glass; and then constructed a differential torsion balance to which these could be attached, of the following nature:—A horizontal lever was suspended by cocoon silk, and at right angles, at the end of one arm, was attached a horizontal cross-bar, on which, at about $1\frac{1}{2}$ inch apart, and equidistant from the horizontal lever, were suspended the glass bubbles; and then the whole being adjusted so that one bubble should be on one side of the iron core and the other on the other side, any difference in their tendency to set inwards or outwards from the axial line caused them to take up their places of rest at different distances from the magnetic axis; and the power necessary to bring them to an equidistant position became a measure of their relative magnetic or diamagnetic force.

In the first place, different gases were tried against each other, and when oxygen was one of them it went inwards, driving every other

outwards. The other gases, when compared together, gave nearly equal results, and require a more delicate and finished balance to measure and determine the amount of their respective forces.

The author now conceived that he had attained to the long-sought power of examining gaseous bodies in relation to the effects of heat and the effects of expansion separately; and proceeded to an investigation of the latter point. For this purpose he prepared glass bubbles containing a full atmosphere, or half an atmosphere, or any other proportion of a given gas; having thus the power of diluting it without the addition of any other body. The effect was most striking. When nitrogen and oxygen bubbles were put into the balance, each at one atmosphere, the oxygen drove the nitrogen out powerfully. When the oxygen bubble was replaced by other bubbles containing less oxygen, the tendency inwards of the oxygen was less powerful; and when what may be called an oxygen vacuum (being a bulb filled with oxygen, exhausted, and then hermetically sealed) was put up, it simply balanced the nitrogen bubble. Oxygen at half an atmosphere was less magnetic than that at one atmosphere, but more magnetic than other oxygen at one-third of an atmosphere; and that at one-third surpassed the vacuum. In fact, the bubble with its contents was more magnetic in proportion to the oxygen it contained. On the other hand, nitrogen showed no difference of this kind; whether a bubble contained that gas more or less condensed, its power was the same. Other gases (excepting olefiant and cyanogen) seemed in this first rough apparatus to be in the same condition. The air-pump vacuums of all the gases were alike, including that of oxygen.

Hence the author decides upon the place for zero, and concludes that simple space presents that case. When matter is added to space it carries its own property with it there, adding either magnetic or diamagnetic force to the space so occupied in proportion to the quantity of matter employed; and now thinking that the point of zero is well determined, he concludes to use the word magnetic as a general term, and distinguishes the two classes of magnetic bodies into paramagnetic and diamagnetic substances.

There is no other gas like oxygen: its paramagnetic character is very high. A solution of protosulphate of iron in distilled water was prepared, of which a certain bulk in a glass bubble was of the same paramagnetic force as an equal volume of oxygen; the solution was then of such strength as to contain of crystallized protosulphate of iron seventeen times the weight of the oxygen which could counterbalance it. In another case, a glass bubble, containing one-third of a cubic inch of oxygen, was opposed to a corresponding bubble having within only an oxygen vacuum. As soon as the magnetic power was on, the oxygen passed inwards, and it required a force equal to one-tenth of a grain to hold it out at the equidistant position.

The author then refers generally to the air as a paramagnetic medium, because of the oxygen it contains, and in the next, or Twenty-sixth Series of Researches, he proposes to enter, after some preliminary inquiries, into the great subject of atmospheric magnetism.